

INSTRUCTION MANUAL

NO. 6410



Wheelco Instruments

model 410 CAPACITROL

**Effective for Models starting with
Serial No. 95K780**

**WHEELCO INSTRUMENT DIVISION
BARBER-COLMAN COMPANY, ROCKFORD, ILLINOIS**

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NOTE: This instruction manual to be given to persons responsible for installation and maintenance of this instrument.

GENERAL DESCRIPTION

The Model 410 CAPACITROL is a millivoltmeter type indicating controller, producing a stepless — proportioning output current. The output will vary, when in the proportioning band, from a maximum of approximately 17 volts DC down to 0.5 volts or less.

The intended application of the Model 410 is in combination with any of the Wheelco three-function magnetic modulator devices. These are designated as the MMC (current output), MMP (position type), and MMD (duration type). Used in any of these combinations, the instrument is capable of a high degree of reproducibility and fast response where close control of the process is critical. These three function controllers retain the stability of proportional control, the ability to eliminate offset or "droop" because of automatic reset, and the ability to provide a much faster correction due to rate control. In addition, the effective proportioning band of the Model 410 becomes adjustable over a much wider range due to the MM type adjuster.



UNPACKING INSTRUMENT

This Wheelco Instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories carefully from the packing box when delivered, and check items with the packing slip. If the equipment is found to be damaged in transit, report the extent of damage to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

- Handle with care.

- (Before and after installation)

- Safeguard instrument from shock.

- Avoid exposure to moisture.

- Keep instrument temperature under 130°F.

MOUNTING INSTRUCTIONS

Locate the instrument to avoid shock, excessive vibration, moisture and temperatures over 130°F. Avoid furnace walls, radiation of heat, machine frames and outside walls. Provide suitable shelter to avoid moisture and temperature extremes if installed outdoors.

For surface mounting, reverse the three lugs on the back of the instrument housing. See the surface mounting dimension drawing.

For flush or panel mounting, remove the brackets on either side of the instrument housing, insert the instrument through the panel opening, replace the brackets and tighten firmly. See the flush mounting dimension drawing.

MOUNTING DIMENSIONS

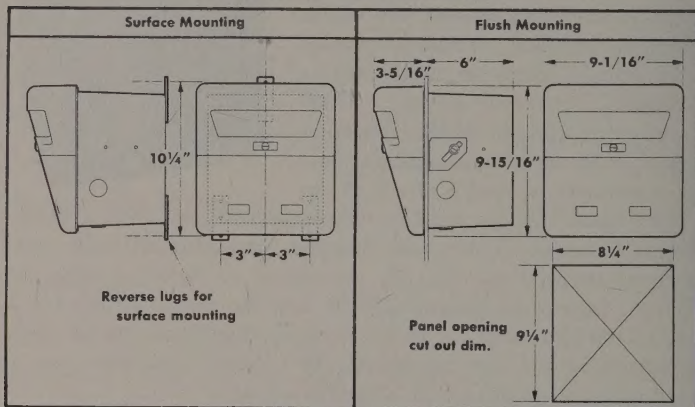


FIGURE 1

Standard flush and surface mounting dimensions

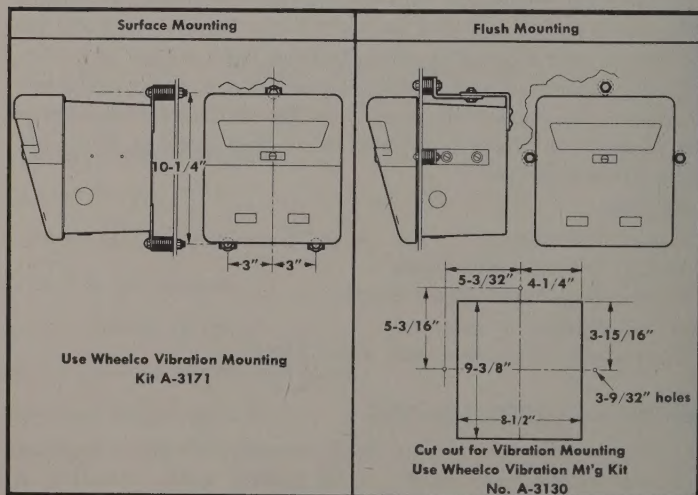


FIGURE 2

Special vibration mountings

The Magnetic Modulator unit is mounted separately but as near the Model 410 as desired for convenient wiring. The Pilot Amplifier, when used, must be mounted in an upright position unless the small percentage meter supplied with it is mounted externally. It is recommended that the amplifier and magnetic modulator be located away from excessive vibration and heat. The ambient temperature should not exceed 130°F.

Further details for the mounting of accessory equipment will be found in the instruction sheets shipped with the equipment.

POWER WIRING

Before connecting power to this instrument, check the supply voltage and frequency with the nameplate ratings on the control chassis. The supply voltage and frequency data is found on the chassis front. Connect supply to L1 and L2. Run all wiring in rigid conduit, Bx or Greenfield in accordance with the recommended electrical code. Tighten the binding screws on the instrument terminal board so as to secure the wires permanently. No. 14 gauge solid wire is recommended for wiring to instrument, and throughout the rest of the control circuit. If stranded wire is used, tin ends to provide secure terminal connections. Be certain that the wires are so placed to not interfere with chassis insertion nor housing front. Ground the instrument case, or make certain conduit system is properly grounded. Do not run thermocouple leads with any power or control wiring. To alter the control chassis in the field for different line voltages, change the transformer primary connections in the chassis per the following:

- 230 VOLT Solder green wire to chassis pin 12 (L1), red-white wire to chassis pin 10 (L2). Solder green-yellow wire to red wire and tape connection.
- 115 VOLT Solder red and green wires to chassis pin 12 (L1). Solder red-white and green-yellow wires to chassis pin 10 (L2). See internal wiring diagram page 22.

THERMOCOUPLE WIRING

Use only extension lead wire correct for the type of thermocouple (TC) as specified on the scale. The most commonly used types are: Iron-Constantan (I/C), Chromel-Alumel (C/A), Platinum-Platinum 10% Rhodium (Pt/Pt 10% Rh), Platinum-Platinum 13% Rhodium (Pt/Pt 13% Rh). Ordinary copper wire will NOT serve the purpose, except for use with Heat Eye or other radiation de-

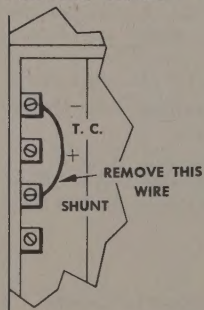
tectors which are compensated internally for lead wire resistance. The measuring circuit system is normally designed for an external resistance of 15 ohms (check scale). 15 ohms is usually ample resistance for most lead wire runs. Find resistance of lead wire and subtract from specified external resistance as found on scale. The remaining resistance must be inserted internally by means of a removable resistance strip found in the chassis compartment. This compensating resistor strip is furnished on all original installations. Other values can be obtained from Wheelco at a nominal cost.

Proper polarity (plus) and (minus) of the lead wire must be observed to obtain correct readings. In case of splicing the lead wire (splicing is not recommended) use soldered connections, and splice plus to plus, and minus to minus.

The negative TC lead wire is always coded red. Correct polarity can be checked by heating a temporary junction of the lead wire at the far end to deflect the meter upscale. When connected with a thermocouple, the proper lead wire connections are necessary for obtaining correct readings. Wrong polarity of the lead wire causes low readings of varying amounts, depending on temperatures at the junction points. If the meter reads backward with the TC connected, reverse the connections at the thermocouple head, since the lead wire polarity has previously been checked for correctness.

Locate the lead wire away from the chassis socket strip and housing gaskets.

METER SHUNT WIRE



After the instrument is installed, remove the jumper wire from between terminals "S" and "T.C. -".

This wire is used to short out the meter movement for shipping purposes only and should be replaced when shipping the instrument to prevent damage to meter. Avoid placing wires in the chassis compartment that may interfere with the chassis or gasketed cover.

TCB WIRING

The Model 410 is furnished with thermocouple burnout safety feature (TCB). Essentially it is a voltage that can be wired into the thermocouple circuit to drive the movement upscale in case of an open circuit in the thermocouple, thus passing the limit or control point and causing the fuel flow to be shut off. Normally, the low

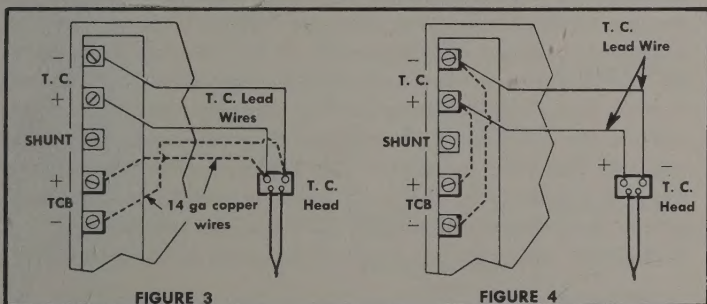
resistance of the couple shorts the impressed TCB voltage down to an extremely low value and the TCB compensation is small. If the couple should open circuit for any reason, the TCB voltage is then impressed across the high resistance of the meter movement driving the meter indicator upscale. Do not connect TCB when instrument is used in conjunction with Heat Eye (radiation calibrations), or with a Model 350 Reference Voltage Source. See Model 350 instruction manual for complete instructions.

The TCB can be wired in two different manners:

- (1) If lead lines are short, it is permissible to wire the TCB directly to the TC terminals as shown in Figure 3.
- (2) In case of long lead wires, copper wires should be run from the TCB terminals to the thermocouple head and connected + to + and - to -. See Figure 4. Long lead lines will develop large voltage drops, if wired in first example above, and necessitate large TCB corrections.

To check proper operation:

- (A) Disconnect the thermocouple from the head, simulating an open circuit.
- (B) With the control index previously set above normal operating point, the temperature indicator should swing above the control set point and reduce heat input to a minimum.



Failsafe: Inasmuch as the MMP and MMD require a negative increase in power to "turn on" or increase fuel (see section on Electronic Circuit Description), it is possible that a malfunction or power failure in 410 unit could cause the MMP or MMD to call for maximum power. It is definitely recommended that additional safety equipment such as Wheelco Model 711 Limitrol be used to safeguard equipment and material when using MMP and MMD with the Model 410 unit. The MMC is inherently failsafe due to increasing signal necessary to obtain MMC output.

METER ADJUSTMENTS AND CHECKS

The indicating pointer should come to rest at the ambient temperature when the lead wire and TCB is disconnected at the instrument. Use a thermometer as close as possible to the TC terminals in the instrument to determine the ambient temperature. This is called the cold junction reading since the lead wire, in effect, extends the thermocouple to the TC terminals of the instrument.

If the indicating pointer does not come to rest at the ambient temperature, slowly turn the adjusting screw, located at the top of the case, to give proper reading. Further deflection as the ambient temperature changes is automatic, since the meter has automatic cold junction compensation.

For temperature scale calibration follow instructions F-6434, using Wheelco Model 330 portable potentiometer.

It is seldom necessary to compensate for TCB, which may cause the meter to read insignificantly high when the instrument is powered. It is not necessary where the thermocouple itself has the usual near-zero resistance. Should it be desired to compensate for this upscale deviation, it may be done by shifting the reading downscale to correspond to the TCB effect as explained below:

With the instrument previously adjusted for correct ambient temperature, the thermocouple should be held at a steady temperature while observing the difference in meter readings with the instrument powered and unpowered. If the difference is discernable, compensation may be made with the zero adjusting screw in order to lower the indicating reading, with the instrument powered, to the same point of deflection observed when the power was off. The cold junction or ambient adjustment is thereby changed downscale by this same corrective deflection. An alternate method to make this check is by making and breaking the TCB circuit, rather than through off-on power to the instrument.

DESCRIPTION OF ELECTRONIC CIRCUIT — MODEL 410

The Model 410 is an extension of the basic 400 series control family. The familiar Electronic Link principle is incorporated here to sense the position of the meter pointer in respect to the control set point.

Unlike the other instruments in the 400 series, the Model 410 chassis employs a two stage oscillator — amplifier circuit with a *reversed* tuned grid — tuned cathode oscillator, as a means of obtaining correct control action of any of the MM series controllers.

When the vane, carried by the temperature pointer, passes upscale between the pick-up coils mounted on the set point arm, the oscillator section of the circuit goes out of oscillation, causing the amplifier section not to conduct. (The amplifier section of the 12AU7 electronic tube is a resistance coupled cathode follower operating from the output of the oscillator section.) At this position of the pointer vane, the output of the oscillator section is maximum, though negative, and the amplifier output is minimum and positive.

The reverse is also true that when the temperature pointer is down-scale well below the control set point — that is, with the vane out of the pick-up coils, the oscillator section is caused to oscillate and permits the amplifier to conduct. This time the output of the oscillator section is minimum, though less *negative*, and output of the amplifier is maximum and positive.

The purpose of this circuit design is to provide proper input characteristics to the magnetic modulator series controllers. (See section under MM Series Controllers.) Figure 5 shows diagrammatically the electronic tube output in its two sections as supplied to the MM controllers.

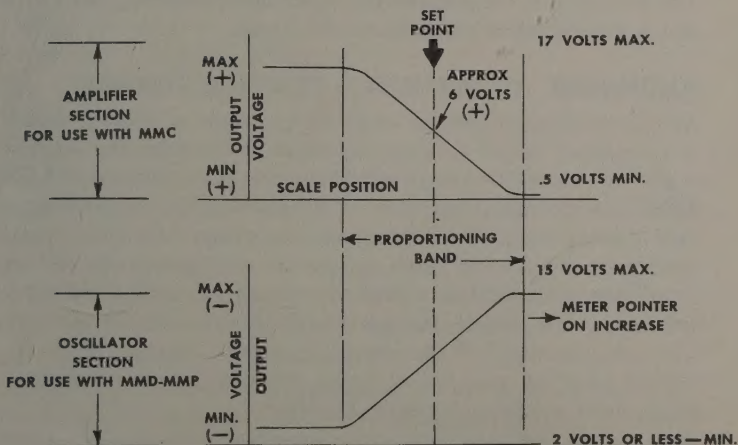
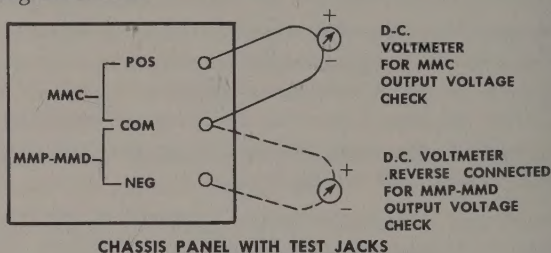


FIGURE 5

The electron tube output is controlled between one half volt DC minimum output, to 17 volts maximum (positive) in the amplifier section, and from 2 volts to 15 volts (negative) in the oscillator section. The output at any time depends upon flag position and section of circuit measured. These voltages are conveniently measured at the three test jacks on front of the plug-in chassis.

NOTE: Use a voltmeter of 10,000 ohms per volt sensitivity for this test. See diagram below.



The control chassis is designed to plug in to the instrument compartment providing excellent service arrangement or for changing to other modes of control as provided in the 400 Series. The control point setting knob is located directly beneath the instrument scale and is easily adjustable but protected against accidental shifting. The model number will be found on the control set point knob. The green signal lamp is powered from the transformer secondary and is lighted when power is on the chassis.

ALIGNMENT ADJUSTMENT — CONTROL TUNING

An alignment adjustment is needed in case there is "droop," which is a condition where the temperature is held steady, but slightly away from the control set point. The tuning adjuster screw, labeled RESET, is located on the front of the chassis. This adjustment is used to bring the indicated temperature into alignment with the red control set point, after allowing time for the temperature to line-out. When not coincided, a small adjustment will make a noticeable correction, but several minutes should be allowed for the new "line-out" to result. If the indicating pointer lines out above the control set point, turn the adjusting screw clockwise; if below set point, make a counterclockwise adjustment.

Once the manual adjustment for "droop" has been correctly tuned for a steady temperature and proportioning band width is fixed, the magnetic modulator will automatically reset to restore control at set point after any alteration in process demand.

PROPORTIONING CONTROL

The proportioning band width, or throttling range, is adjusted by positioning a dial knob located at the left side of the instrument chassis and marked MAX — MIN. The band is narrowed when turning the knob clockwise and widened when rotated counter clockwise and is adjustable between 1.0 and 7.0% of meter span. However, in order to allow the major adjustment to be made with the magnetic modulator, it is recommended that meter adjustment be made with the dial knob positioned approximately at midpoint on initial start-up. Subsequent changes in band width may then be made in conjunction with the proportioning band adjustment of the MM Series controller.

Widening of the proportioning band will serve to reduce the amount of over and under-shooting of load temperature. Fast temperature change applications with short dead time should be handled with a narrow proportioning band adjustment, using wide band adjustment (on the Model 410) when slow response is evident.

MM SERIES CONTROLLERS — GENERAL

Used in conjunction with the Model 410, the Wheelco magnetic modulated controllers are three-function — providing proportional plus reset plus rate control, and each with separate and extensive adjustment. These controllers make it possible to maintain a process continuously at the desired value. Even when a disturbance occurs, causing excessive deviation of the controlled variable, a quick return to the set point will follow.

The MMC is a current output type of three-function controller, used to control a variety of final control devices such as electro-hydraulic valve operators, magnetic amplifiers and servo positioning units. The overall circuitry generally employs the use of a pilot amplifier (such as the Model 610A) for intermediate power amplification, and a saturable core reactor as the final control element. The use of the MMC in the circuit ahead of the pilot amplifier makes available its features of automatic rate and reset action, integrated with the stepless proportioning control from the Model 410. Used as a *position* type of controller, the "MMP" relay action determines the rotation and positioning of a valve, or the actuating of a valve positioning device, in controlling fuel output. Normally a Barber-Colman Type MP Power Unit is used as the final control operator.

The MMD or *duration* type three-function controller, uses its output to regulate the duration, or on-time, of an electrical input contactor,

or the full open interval of a motor operated or solenoid operated valve. This achieves a pulsing type of control action when the meter is in the proportioning hand.

MM CONTROLLERS—ELECTRONIC CIRCUIT DESCRIPTION

NOTE: For a more extensive description of the MM controllers, refer to the particular instruction manual supplied. The brief statements here describe only their action as adapted to the Model 410. The magnetic modulator receives a DC signal from the Model 410, adds automatic reset for droop correction, and automatic compensation for rate of approach with any deviation from control point. Whenever the indicator pointer of the Capacitrol is not at coincidence with the set point, the difference in output voltage, from that produced at set point, creates an unbalance in the modulator network. Briefly stated, the modulator adds or subtracts this amount of difference, amplifies the result, feeds it to a phase detector circuit, and through relays, corrects the power output to the final control element.

In circuit with the Model 410, the MMC receives its input voltage from the amplifier section of the electronic tube in the Model 410 chassis. On an upscale deflection through the proportioning band, the voltage output to the MMC will vary from 11-17 volts DC to a low of less than 2 volts DC. The MMD and MMP series receive their input voltages from the output of the oscillator section of the Model 410, resulting in a voltage increase but with negative polarity, as the indicator pointer moves upscale through the proportioning band. The voltage will vary from minus (—) $\frac{1}{2}$ volts DC to approximately minus (—) 11 volts DC.

CAUTION: For installations using the MMP or MMD Series controllers, make certain that the MM controller is never left powered with the Model 410 unpowered, or permit any circumstance that could create a prolonged zero output from the Model 410 (such as a malfunctioning). Such condition may cause the furnace to turn on and possibly reach an excessive temperature.

PILOT AMPLIFIERS AND REACTORS

The pilot amplifier is a magnetic amplifier connected between the MMC and a saturable core reactor. The amplifier receives the small DC output current from the control, and makes available a much larger (approximately 180 times) current needed to saturate the magnetic core of the load current reactor. The reactor is essentially a large choke coil with a DC control winding wound on the iron

core along with the AC windings. Direct current, passing through the control windings, saturates the iron thereby reducing the inductive effect of the AC, and permits a much greater alternating current to flow. The amount of current flow in the load winding is proportional to the DC current in the control winding.

Pilot amplifiers available are:

Model 610A, 120 V. 60 cy., max. output 188 V.A. for reactors up to 30 K.V.A.

Model 611A-S297, 120 V. 60 cy., max. output 250 V.A. for reactors up to 80 K.V.A.

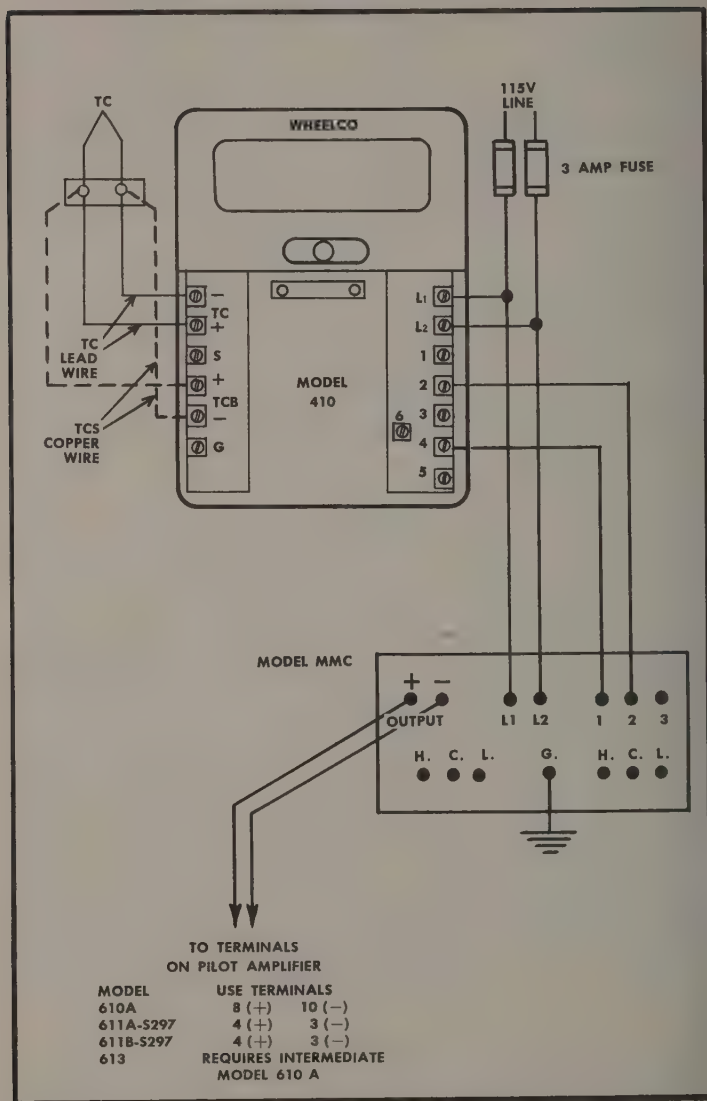
Model 611B-S297, 220 V. 60 cy., max. output 250 V.A. (8-150 V. DC) for reactors up to 80 K.V.A.

Model 613, 220 V. 60 cy., max. output 500 V.A. (8-150 V. DC) for reactors over 80 K.V.A., up to and including 200 K.V.A. single phase or when used in multiples up to 600 K.V.A. 3 phase.

A second intermediate unit, called 613 pilot amplifier, is needed with the larger industrial size reactor control systems, for increased control current. The first pilot amplifier, 610A, receives the proportional DC current output from the MMC controller, and then delivers a magnetically amplified DC current to the secondary amplifier. This secondary amplification is needed on high demand in order to saturate the reactor, which allows a corresponding higher current flow to the connected load.

Proper size reactors and pilot amplifiers are required to provide satisfactory maximum and minimum regulation of the current to the heating elements or other electrical load. Normally, there is some loss of line voltage through the reactor to the load, down to approximately 90 per cent of line voltage with the control output at maximum. The minimum control output is always greater than zero, but should cause the reactor to control at or below 17% of line voltage at the rated load.

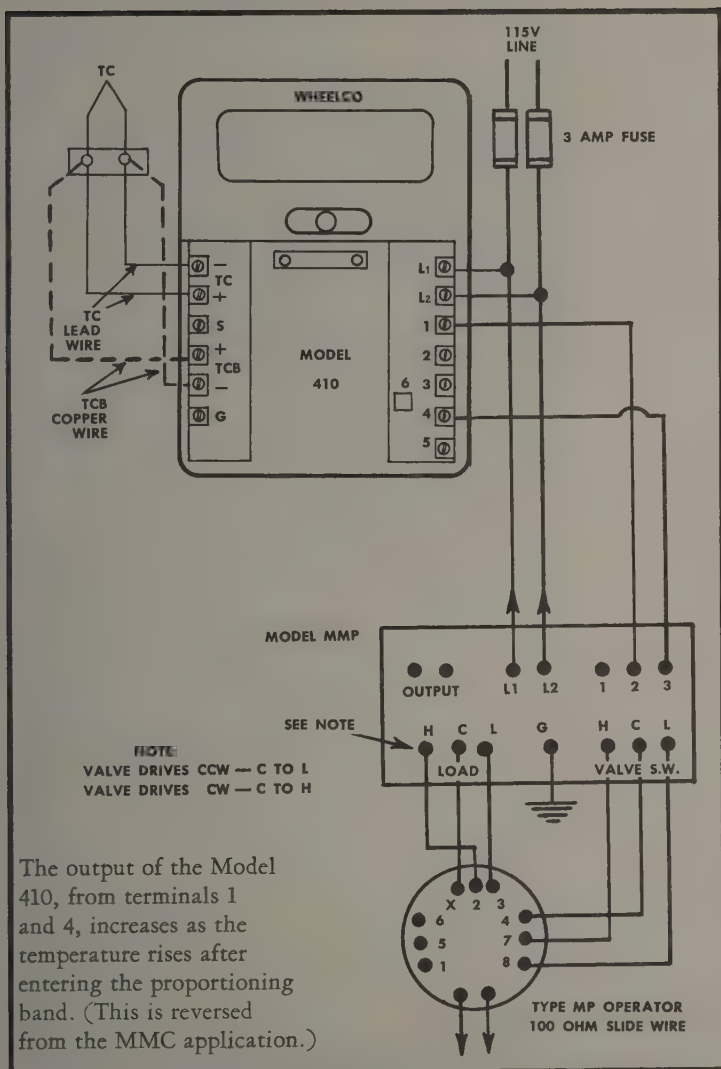
EXTERNAL WIRING DIAGRAM



Model 410 with Model MMC and Model 610A Pilot Amplifier for Current Output Type of Control

NOTE: The output of the Model 410, from terminals 2 and 4, decreases on temperature rise after entering the proportioning band.

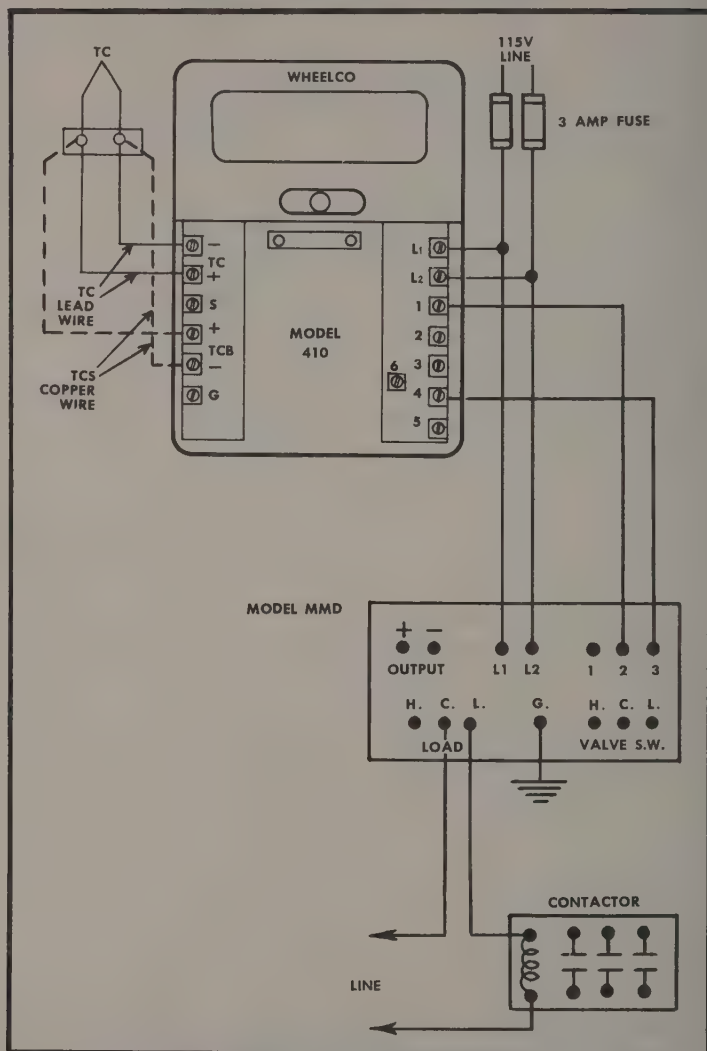
EXTERNAL WIRING DIAGRAM



**Model 410 With Model MMP For Position Type Control Of
Barber-Colman Operator**

As shown, operator will rotate counterclockwise for increased heat input. For clockwise position, interchange terminals 2 and 3 also 7 and 8 on the terminal strip of the Model MP.

EXTERNAL WIRING DIAGRAM



**Model 410 With Model MMD For
Duration Type Control Of Electrical Input Contactor**

NOTE: From terminals 1 and 4 the output of the Model 410 increases on temperature rise after entering the proportioning band. (This is reversed from the MMC application.)

REACTOR WIRING

For those installations using the Model 410 in combination with an MMC, Model 610A pilot amplifier and reactor, special attention is directed to the wiring of the reactor.

In the event that the external control circuit of the reactor should accidentally open while the reactor is under load, high voltage could be induced in the control winding. This could damage the internal insulation and result in a hazard. It is recommended that the shunting resistor always be connected to X1 and X2 of the reactor control windings.

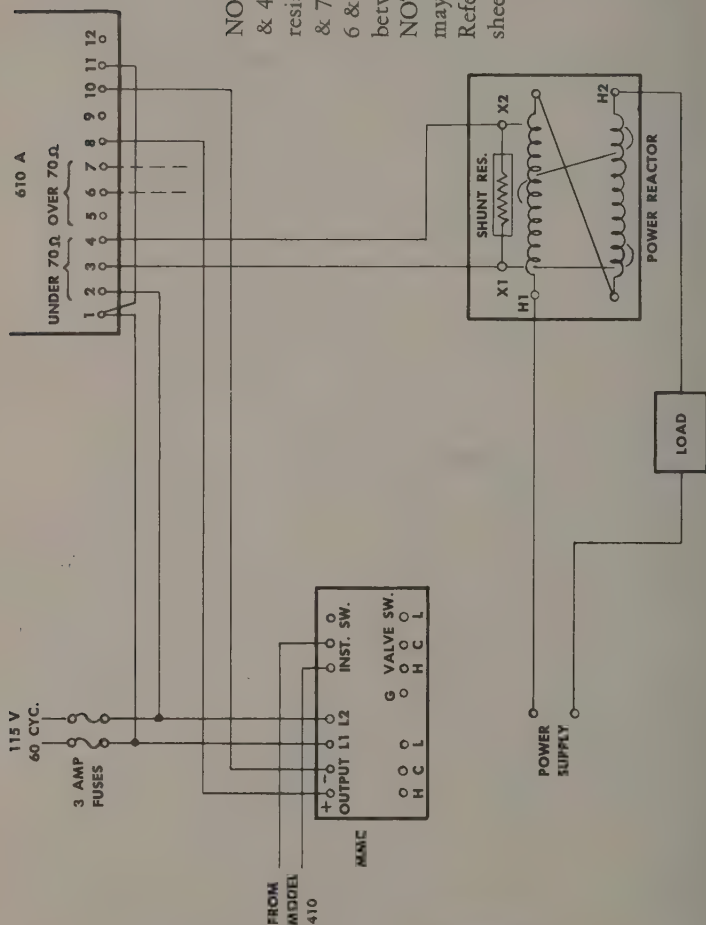
The load circuit of the reactor is connected in accordance with manufacturer's instructions accompanying the equipment, however, figures 5 and 6 show typical wiring schemes for single and three phase applications.

The small meter in the pilot amplifier can be used to approximate the percentage of total reactor load, the 100 reading being equal to maximum power reactor output. When the equipment is powered, the small meter will not read down to zero with minimum reactor output, as the pilot does not completely cut the saturation current to zero.

CONTROL ADJUSTMENT PRIOR TO START-UP

Prior to initial start-up of the instrument system, the trial setting of the proportioning band on the Model 410 should be of approximately one-half position as described in the section on Proportional Control. Although the reset has been factory adjusted for 50% output voltage at coincidence of indicating pointer and set point, and with proportioning band at nominal width, this setting should be checked. Static alignment adjustment should be made with the MM disconnected and a voltmeter across the test jacks of the Model 410. With instrument powered and pointers in alignment, reset should be adjusted for a voltage output of $5\frac{3}{4}$ V. $\pm$ $\frac{1}{4}$ V. To reflect the total circuit effect on the alignment adjustment, a check can be made with the instrument powered and the MM connected. If balance is correct, the small meter on the MM will indicate a 50% position.

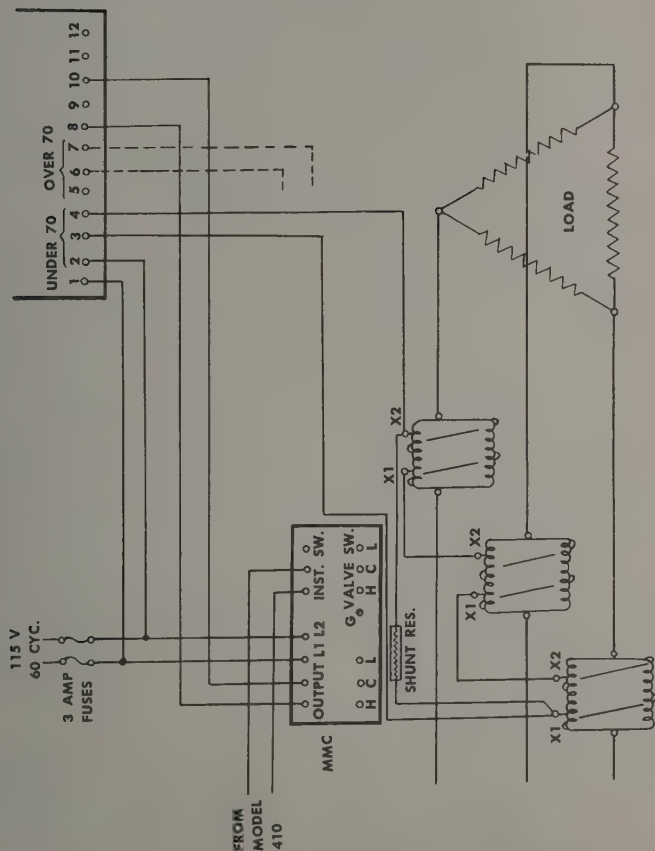
The Model 410 should be checked for ambient temperature with the thermocouple circuit disconnected. The Zero-Adjust should be set to allow the indicator pointer to come to rest at the ambient temperature as measured near the TC terminals of the Capacitrol. Further details of this procedure will be found in the section under Meter Adjustments.



NOTE: Use load term. 3
& 4 if reactor X1 - X2
resistance is between 30
& 70 Ω . Use load term.
6 & 7 if resistance is
between 70 & 150 Ω .
NOTE: Reactor AC coils
may be parallel connected.
Refer to mfgs. spec.
sheet accompanying reactor.

FIGURE 6

Figures 6 and 7 show typical wiring connections commonly used.
Always refer to manufacturer's instructions accompanying reactor.



NOTE: Use load term. 3 & 4 if reactor X1 - X2 resistance is between 30 & 70 Ω . Use load term. 6 & 7 if resistance is between 70 & 150 Ω .

NOTE: Reactor DC coils may be parallel connected in special cases. Refer to mfgs. spec. sheets accompanying reactor.

FIGURE 7

Suggested trial adjustments of the magnetic modulator, for initial start-up, are as follows:

PROP. BAND	— 20%
RESET	— 0
GAIN	— 6
RATE	— 0

The effective proportioning band, according to the above settings, will be approximately 3% of the temperature scale range. With the proportioning band setting of the graduated dial of the MM at 20%, the band width setting of the Model 410 will be retained. Increasing the proportioning band on the MM will increase the effective band, but not in the amount indicated on the dial. Attainable band width of the MM is dependent on the setting of the Model 410. At any combination of proportioning band settings of the two instruments, the cumulative band width is equal to the MM proportioning band width in percent, divided by 20, multiplied by the Model 410 band width percent.

It should be noted that increasing the proportioning band with the MM adjustment to a point beyond the maximum obtainable from the Model 410 alone, has the effect of reducing the maximum and increasing the minimum output voltage. This can be compensated by proper adjustment of reset on the MM series, which effectively restores the voltage to the full amount required for control.

In applications of fast response, where overshooting must be held to a minimum on temperature rise from initial start-up, rate action may be introduced (i.e., .1 on the graduated dial on the MM) together with a widened proportioning band. Widening the band permits rate action to be utilized earlier, since it is not effective until the indicating pointer moves into the proportioning band.

TRIAL RUN ADJUSTMENTS

NOTE: The statements in this section describe the recommended procedures to be used for control adjustments of the Model 410 Capacitrol, which are additional to adjustments made on the MM device used with it. The instruction manual supplied with the MM should be studied and its directions followed closely for setup and operation. Properly adjusted, the Model 410 feeds an input voltage to the MM controller which, in essence, duplicates the action of the potentiometer recorder slidewire to which the MM instruction

manual makes reference. Consequently, those instructions also generally apply when used with the Model 410.

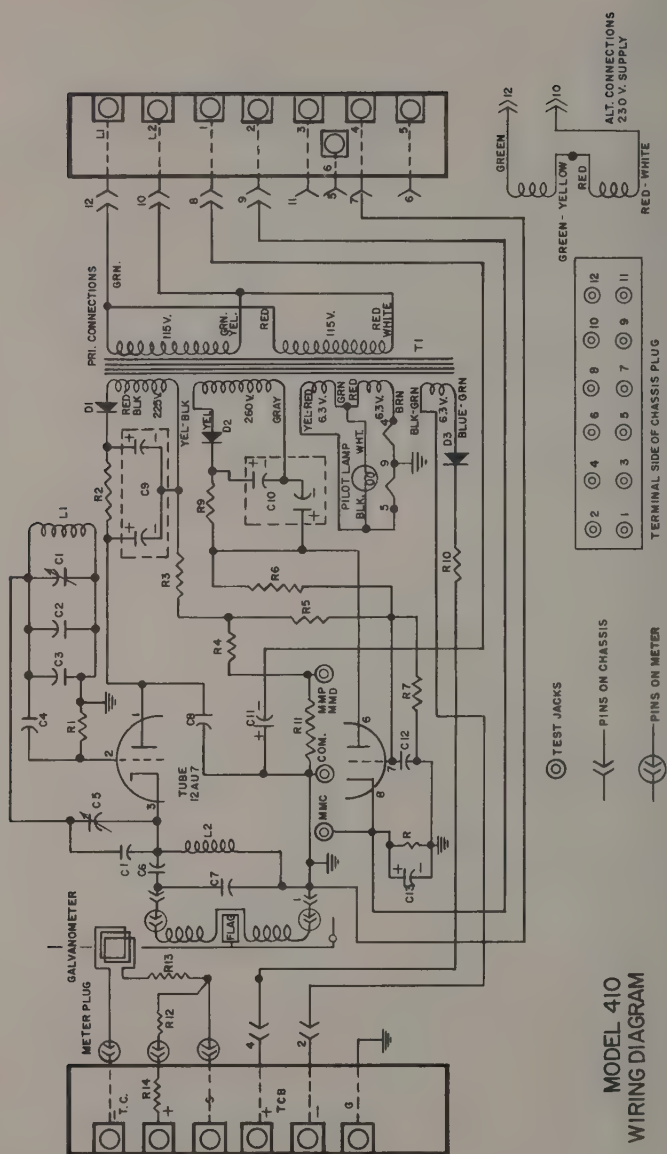
As noted in the MM instruction manual, initial start-up is made with the MM selector switch on MANUAL, during which time attempts are made to obtain control without cycling. Under AUTO operation, if the temperature continues to overshoot and undershoot, the proportioning band of the magnetic modulator should be increased as required. Rather than use all the available adjustment on the MM, an increase may be made using the adjustment on the Model 410. If it is found that temperature does not quite reach control point, it may be that the proportioning band is too wide. Further band width reduction should be made on the Model 410 if the MM adjustment has reached a low of 20%.

Changes in the proportioning band by use of the Model 410 adjustment should be made as infrequently as possible, inasmuch as this will cause "droop" and require a readjustment of reset. After allowing sufficient time for the indicator pointer to "line-out," turn MM selector switch to AUTO and rotate the reset adjustment screw on the Model 410 chassis clockwise to lower, and counter-clockwise to raise the controlled temperature to align the two pointers. (See section on Alignment Adjustment.) Band width changes made by the MM adjustment may also cause the indicator pointer to "line-out" momentarily above or below control point. However, it will be brought quickly into alignment by the introduction of a proper amount of reset using the adjusting knob on the MM panel. The automatic reset feature of the MM will then continue to restore alignment upon any change in process demand.

The final point of band width adjustment will vary with furnace capacities and heat rates, and must be determined for each individual installation.

Generally, the most satisfactory control system should be operated with the narrowest proportioning band without temperature cycling, and with the MM adjustment of Rate and Reset sufficient to bring indicator to control point in good order. The MM instruction book should be consulted for trial settings of these adjustments.

With the correct adjustment of proportioning band, reset and rate, with respect to each other, the indicating pointer will be observed to approach the control set point at a decelerating rate. It will come to rest at the set point, and hold with good stability until the next major control upset. At this time action will be accurately reproduced.



DRAWING SYMBOL	VALUE	PART NO.
T1	Power Transformer	30-070-1
R1	4.7 Meg Ω , $\frac{1}{2}$ W	CYZR-170-42
R2	470 Ω , $\frac{1}{2}$ W	CYZR-170-32
R3	7.5 K Ω , 5 W	40-154
R4	2.5 K Ω , 3W	40-129
R5	47 K Ω , $\frac{1}{2}$ W	40-070-2
R6	1.5 Meg Ω , $\frac{1}{2}$ W	40-021
R7	1 Meg Ω , $\frac{1}{2}$ W	CYZR-170-41
R8	1 K Ω , $\frac{1}{2}$ W	CYZR-311-1
R9	470 Ω , $\frac{1}{2}$ W	CYZR-170-32
R10	27 K Ω , $\frac{1}{2}$ W	CYZR-170-7
R11	1 K Ω , $\frac{1}{2}$ W	CYZR-311-1
R12	Range Multiplier (Specify type, range and serial no.)	
R13	Neg. Temp. Coeff. Assy.	A-3049-1
R14	Lead Comp. Resistance	A-3641
C1	8-50 MMFD, Variable	39-105
C2	22 MMFD, 500 V	39-103
C3	15 MMFD, 500 V	39-013-1
C4	.002 MFD, 600 V	39-100
C5	29-35 MMFD, Variable	39-122
C6	100 MMFD, 500 V	39-069
C7	15 MMFD, 500 V	39-013-1
C8	.01 MFD, 500 V	CYZR-220
C9	20-20 MFD, 400 V	39-156
C10	20-20 MFD, 400 V	39-156
C11	25 MFD, 25 V	39-147
C12	.05 MFD, 600 V	39-041-2
C13	25 MFD, 25 V	39-147
C14	1.5 MMFD, 600 V	39-157
D1	Sel. Rect. 13 V	37-009
D2	Sel. Rect. 260 V	37-010
D3	Sel. Rect. 260 V	37-010
L1	Osc. Coil 0.5 μ h	41-120-1
L2	Choke Coil 75 μ h	41-124
	#51 Bulb - 6.3 V	36-022-1
	12 AU7 Tube	EYZP-70-9

MODEL 410

MAINTENANCE AND SERVICE CHECKS

While the 410 Series instrument is well designed and manufactured of high grade components, it is worthwhile to have information as to service and spare parts for emergency servicing. Where a number of instruments are located together, the plug-in parts are interchangeable and allow a minimum inventory.

Upon experiencing a trouble complaint, the serviceman should familiarize himself with the process and instrument application to ascertain the exact function of the instrument as applied. The instrument trouble usually can be traced to two basic problems, measurement or control.

Measurement trouble can be detected by observing the pointer position.

If the measured temperature is known to be in error, check the following:

- (1) Open thermocouple circuit, such as break in thermocouple or lead wiring.
- (2) Deteriorated T.C. hot junction due to burning.
- (3) Multiple shorts or grounds creating erroneous cold junctions.
- (4) High resistance in leads due to loose connections, dirty switch contacts, poor splicing, and other faulty connections.
- (5) Check for vibration or shock.

Control trouble may be detected by observing control point and indicated temperature position. If the temperature is not at the control point:

- (1) Adjust manual reset to align pointers.
- (2) Check power input for low maximums if temperature will not rise to control point.
- (3) Check power input for high minimums if temperature will not hold to control point. Minimum load voltage, 17% of line voltage.
- (4) Is load matched to reactor size?
- (5) Determine if instrument and pilot amplifier are powered; check load power for open circuits and open legs in three phase circuits.
- (6) Determine if correct output potential is obtained. Measurement is conveniently made at the instrument by connecting a DC voltmeter to the applicable test jacks on the chassis as follows:

When checking required output for an MMC hook-up, the testmeter should read between 11 and 17 volts DC *positive*, with the indicator pointer well below the red control set pointer. With the indicator above the red control pointer, (flag in the pick-up coils) the meter should read 2 volts or less.

For installations using an MMP or MMD, control action is reversed from the above. At an indicated temperature well below the control set point, a voltmeter placed across the test jacks will show the output to be *negative* and in the range of from $\frac{1}{2}$ to 2 volts DC, depending on proportioning band setting. With the indicator well above the red set pointer (flag in pick-up coils), the output will increase to a maximum of 10 or 11 volts DC, again with negative polarity.

If tube replacement does not give correction, other circuit defects are apparent.

- (7) Replace electronic tube.
- (8) Replace chassis.
- (9) Check for excessive vibrations.
- (10) Measure supply for low voltages. Common low voltage to all components will cause large vibrations in available power to load.

For servicing of Magnetic Modulator (MM Series) consult instruction manual supplied with the unit.

In event it is found necessary to remove the plug-in meter assembly, follow steps below.

- (1) Remove set point adjustment knob (Bristol No. 6 wrench).
- (2) Remove four cover screws.
- (3) Remove cover straight forward to prevent damage to internal meter parts.
- (4) Loosen screws in lower meter chassis corners.
- (5) Insert fingers behind pulling lugs and pull very gently.

Reassembly is of reverse procedure being careful to line up the slotted lever for the zero adjustment pin when installing gasketed cover. Reinstall set point knob.

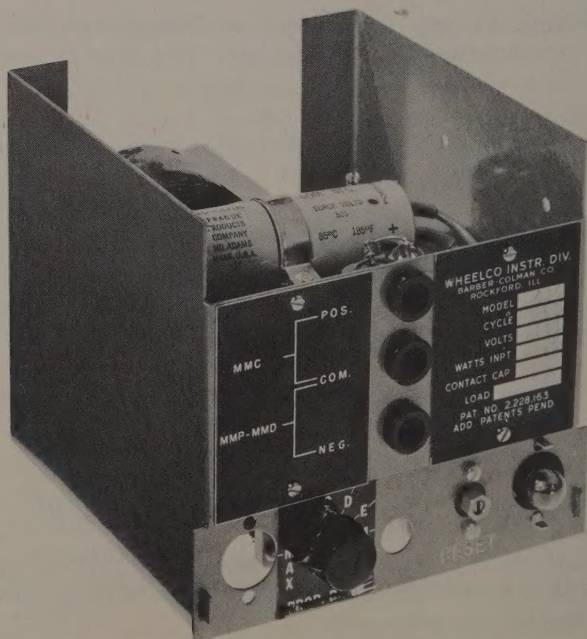
SUGGESTED REPLACEMENT PARTS

It is recommended that a few spare parts be carried by the user to insure against possible emergencies and accidental damage. We do not recommend electronic component replacement except by well equipped instrument repair shops. The following parts are recommended to be carried:

- | | |
|--|--------------------|
| *1 Electronic tube (12AU7) | Part No. EYZP-70-9 |
| 1 Mazda pilot lamp (#51 blue bead) | Part No. 36-022 |
| 1 Model 410 control chassis | Part No. A-4242 |
| specify by instrument serial no. and voltage | |
| 1 Replacement thermocouple | |
| (See original order) | |

*NOTE: Wheelco policy is to recommend purchase of the 12AU7 tube from the Wheelco Instruments Division, Barber-Colman Company to ensure instrument functioning as designed. Tubes are purchased under rigid specifications.

A more rugged industrial tube is available which has a normal life in excess of 10,000 hours. Order tube No. 5814.



MATERIAL WARRANTY: All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge, if returned immediately, prepaid to the factory at Rockford, Illinois. The seller shall not be liable to the purchaser, or to any other person, firm or corporation for any direct, indirect or consequential damages or injury of any kind or character; that by acceptance of such equipment the purchaser shall accept and assume all liability for any and all damages or injuries that may result from the use or misuse of such equipment by the purchaser, or by any other person, firm or corporation; and that there shall be no other warranty whatever, expressed or implied, with respect to such equipment.



Warranty and Inspection Card — PLEASE FILL OUT AND RETURN

This equipment is guaranteed in accordance with the statement of warranty appearing on our quotation and acknowledgement forms. Upon receipt of this card properly filled out Warranty becomes effective. All Wheelco instruments are manufactured to the highest standards of quality and are carefully inspected before packing. Instruments which have been damaged or fail to operate upon installation, should be reported to the factory at once.

**Wheelco Instruments Division
Barber-Colman Company**

MODEL NO.
SERIAL NO.
CALIBRATION INSP.
FINAL INSPECTION

Date Received		
Company		
Street		
City	Zone	State
By	Title	

COMMENTS

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